Citation:

Flood JE, Roe LS, Rolls BJ. The effect of increased beverage portion size on energy intake at a meal. *J Am Diet Assoc.* 2006 Dec; 106(12): 1,984-1,990.

PubMed ID: 17126628

Study Design:

Randomized Crossover Trial

Class:

A - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

- To examine the effects of increasing beverage portion size on beverage intake, as well as on food and energy intake, during a meal
- A component of the study design was also to compare beverage type (cola, diet cola or water).

Inclusion Criteria:

- 18 to 45 years of age
- Not taking medications that are known to affect appetite or food intake
- Non-smokers
- Regularly consume three meals a day
- Not dieting to gain or lose weight
- Not athletes in training
- Not pregnant or breastfeeding
- Free from food allergies and food restrictions.
- Reported liking both regular and diet soda were eligible.

Exclusion Criteria:

- Body mass index (BMI) less than 18 or more than 40kg/m^2
- Scored more than 40 on the Zung Questionnaire (measures depression)
- Scored more than 20 on the Eating Attitudes Test (measures attitudes toward food and eating).

Description of Study Protocol:

Recruitment

Recruited from The Pennsylvania State University community by informational flyers, electronic mailing lists, and newspaper advertisements.

Design

- A crossover design with repeated measures was used
- Subjects came to the laboratory to eat lunch once a week for six weeks, for a total of six test sessions. On each test day, a standard breakfast of bagels and yogurt was served in order to ensure a consistent level of hunger across sessions. At each lunch, the same foods were served, but the beverage served was varied in type and portion size. At all meals, subjects could eat or drink as much or as little as they wanted from the amount of food and beverage that was served
- The order of experimental conditions was randomized across subjects.

Dietary Intake/Dietary Assessment Methodology

All foods and beverages were weighed prior to being served to subjects, and reweighed after the subjects had finished eating, to determine the amount of food and beverage consumed by each subject to the nearest 0.1 g.

Blinding Used

No. Participants could see if they were drinking water or cola. However, subjects were not given information about the beverage type or portion size that they were served.

Intervention

- At each lunch, one of three beverages was served (regular cola, diet cola or water; PepsiCo, Inc., Purchase, NY) in one of two portion sizes [360 g (12 fl oz) or 540g (18 fl oz)]
- Regular cola was sweetened with high-fructose corn syrup, and diet cola was sweetened with aspartame. The regular soda provided 150 and 225 kcal for the small and large servings, respectively
- Subjects were not given information about the beverage type or portion size that they were served.

Statistical Analysis

- A mixed linear model with repeated measures was used to analyze the main outcomes of energy intake (kcal), food and beverage intake (g), ratings of hunger and satiety and ratings of entrée and beverage characteristics
- The fixed factor effects in the model were beverage type, beverage portion size and subject sex
- Analysis of covariance was performed to determine whether any continuous variables, including subject characteristics and beverage taste ratings, affected the relationship between experimental variables and main outcomes
- Regression analysis was used to determine the relative influence of experimental variables and subject characteristics on outcomes of beverage intake, food intake and total lunch intake
- Results were considered significant at $P<0.05$.

Data Collection Summary:

Timing of Measurements

- Subjects came to the laboratory to eat lunch once a week for six weeks, for a total of six test sessions
- On each test day, a standard breakfast was served
- The order of experimental conditions was randomized across subjects.

Dependent Variables

- Energy intake (kcal)
- Food and beverage intake (g)
- Ratings of hunger and satiety
- Ratings of entrée and beverage characteristics.

Independent Variables

- Beverage type (cola, diet cola or water)
- Beverage portion size [360g (12 fl oz) or 540g (18 fl oz)].

Control Variables

- Sex
- Ratings of hunger, satiety and food and beverage characteristics.

Description of Actual Data Sample:

- *Initial N:* 20 women and 20 men
- *Attrition (final N):* 18 women and 15 men (18% attrition)
- *Age:* 22.0±0.2 years for females; 23.3±0.3 years for males
- *Anthropometrics:* BMI: 22.6±0.3kg/m^2 females; 24.5±0.3kg/m^2 males
- *Location:* United States.

Summary of Results:

Key Findings

- Increasing beverage portion size increased the weight of beverage consumed, regardless of type of beverage served ($P<0.05$)
- Energy intake from food consumed at lunch did not differ significantly across conditions. However, when the energy from beverages was added to the energy consumed from food, mean total energy intake at lunch was significantly greater when regular cola was served, regardless of portion size ($P<0.001$). Therefore, even though subjects consumed more energy from the caloric beverage than the non-caloric beverages, they did not compensate for this additional energy by reducing food intake.

Author Conclusion:

When a caloric beverage was consumed with a meal, food intake was not reduced and energy from the beverage added on to energy from food, resulting in a significant increase in total energy consumed at a meal; further, replacing caloric beverages with low- calorie or non-caloric beverages can be an effective strategy for decreasing energy intake.

Reviewer Comments:

None.

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions		
1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes
Validity Questions		
1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	No
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes

3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	N/A
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	???
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	No
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	No
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	???
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	N/A
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes

6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	Yes
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A

8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes